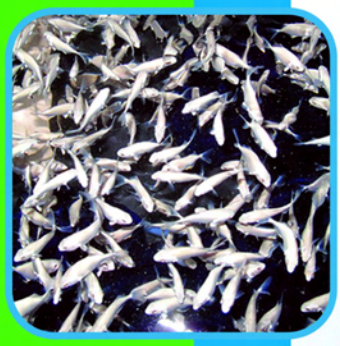

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CMFRI

Prioritized Species for Mariculture in India

भाकृअनुप
ICAR

ICAR - Central Marine Fisheries Research Institute

Prioritized Species for Mariculture in India

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CONTENTS

भाकृअनुप
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FOREWORD

Mariculture has been recognized as an important avenue for ensuring nutritional security of growing fish-eating population in the country, especially in the backdrop of limitation in the availability of land resources and plateauing fish catch from the wild. ICAR-Central Marine Fisheries Research Institute, Kochi has been at the forefront of transforming the mariculture sector of the country through its pioneering research programmes on mariculture of finfishes and shellfishes. Success achieved in seed production and farming of cobia, pompano, grouper and pearlspot in recent years has provided the much needed impetus to this transformation.

Although India has been a home of vast array of marine finfishes and shellfishes, the mere existence of these large number of species does not ensure large-scale expansion of mariculture, since each species possesses unique set of challenges for seed production and farming. A fish farmer needs reliable information on a species and its culture aspects before he/she embarks on its culture. Hence, it is important to have a comprehensive database for potential cultivable finfish and shellfish species available in the country, covering the aspects of biology, their culture potential, status in the wild, economic viability in the culture systems, etc.

I am happy to learn that, in order to prioritize the potential finfish and shellfish species suitable for mariculture in India, an Expert Consultation was organised at Mandapam Regional Centre of ICAR-CMFRI during November 4-6, 2013. Further, it is gratifying to note that, as the outcome of the Consultation, an exhaustive book has also been prepared which includes factsheets for each of the prioritized species. I am sure the book will serve as an important guide for the researchers, farmers and other stakeholders having interest on mariculture in the country.

I deeply commend the effort taken by each and every members associated in the Consultation and further the scientists of ICAR-CMFRI for their invaluable contribution to the preparation of these factsheets and the book.

19/12/2016

(J. K. Jena)

PREFACE

Mariculture holds tremendous potential for fulfilling the demand of fish, as a source of dietary protein in the country. Keeping this in hindsight, ICAR-Central Marine Fisheries Research Institute, for the past several years has been trying to transform the mariculture sector of the country. In India, the potential coastal water area available for mariculture includes about 8.9 million ha of inshore waters for open-sea farming and 1.7 million ha of estuaries, backwaters, brackishwater lakes and swamps. High valued finfishes, crustaceans, molluscs, seaweeds and other marine organisms, possessing high reproductive capacity, short larval development, fast rate of growth, and physiological features to adjust to wide changes in the environment are available in our coastal waters. A large number of unemployed and under-employed fishermen exists who could advantageously take up coastal aquaculture.

Mariculture, in the past, concentrated wholly on culture of shrimps and it is only in the last few years that finfish mariculture has assumed importance. However, information on mariculture of finfish and other shellfishes are scanty with no organised database encompassing all aspects. Seed production technology has been developed by ICAR – CMFRI recently for a few species namely *Rachycentron canadum, Trachinotus blochii, Epinephelus coioides* and *Trachinotus mookalee.* Additionally, a large number of marine species are available in India which are amenable to mariculture but for which there are several challenges which have not been properly documented. With no concerted efforts in the past, it was decided to have a list of prioritized species of finfishes and shellfishes on which focused research can be undertaken in the near future.

In view of the above, in the workshop/consultation held at Mandapam Regional Centre, a list of prioritized finfishes and shellfishes was prepared for foodfish, conservation, ornamental and region-specific mariculture for the country. A total of 76 species was selected and it was envisaged to have a book with factsheets of individual species containing the challenges and the research gaps. This book is aimed at providing an insight into the morphological description; geographical distribution; habitat and biology; breeding in captive conditions; larval and nursery rearing; growout systems including food and feeding, growth rate, diseases and production, market and trade of each prioritized species. Sincere efforts have been put in place for providing reliable data and latest information on the above aspects in this publication. This book would be the first of its kind in India and would serve as a ready reckoner for breeders, farmers, traders, exporters, students and researchers.

We look forward to suggestions and constructive criticism from our readers for further improvement of this publication. We sincerely hope that this book will serve as a guide for selecting species for mariculture in India as well as for focusing mariculture research in India.

We gratefully acknowledge the invaluable contribution made by several scientists of ICAR – CMFRI to make this compilation possible. The authors are also grateful to Sri. P R Abhilash and Sri. David K M (CMFRI, Kochi) and Sri. V Uma Mahesh (RC of CMFRI, Visakhapatnam) for the figures and line drawings in the book. Thanks are also due to Dr. Boby Ignatius (CMFRI, Kochi), Dr. Vinod K (RC of CMFRI, Calicut), Dr. M K Anil (RC of CMFRI, Vizhinjam) Dr. Venkatesan V and Dr. Vidya R (Molluscan Fisheries Division, CMFRI, Kochi), Dr. I Jagadis, Dr. Asha P S and Smt. M Kavita (RC of CMFRI, Tuticorin), Sri. K Mohammed Koya and Sri. Vinaya Kumar Vase (RC of CMFRI, Veraval), Dr. Anulekshmi C (RC of CMFRI, Mumbai) and Dr. R Saravanan (RC of CMFRI, Mandapam) for their help during the preparation of this book. We gratefully acknowledge the efforts of Dr. Akhilesh K V (RC of CMFRI, Mumbai) in this work. We also thank Sri. P Pranav, Sri. Chinnibabu B, Sri. Jishnudev M A, Sri. P Bhaskar Rao, Sri. V Venkateswarlu and Sri. P Venkatesh for help with fish work.

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Overview of "Species Prioritization for Mariculture/Conservation in India"

India is set to become the most populous nation by 2050 with the demand for fish estimated to be as high as 20.23 mt in the country by then. The marine fishing sector is thus faced with the daunting task of providing at least 10 mt in the coming years to sustain our growing population. With catches from the wild plateauing around 4.5 mt, it is not easy for the marine fisheries sector to rise to the challenge of feeding hungry mouths. It is in this context that mariculture gains importance and is poised as the most important option to ensure food security in the country.

CMFRI has thus embarked on an ambitious journey to revolutionize the mariculture sector of India. So far the potential for mariculture has not been realized fully in the country. Other than culture of shrimps in coastal brackishwater areas, emphasis on other species has been relatively poor. It is in this background that CMFRI is currently engaged in developing standard package of practices for a number of marine finfish species to be transferred to fish farmers in future. Seed production technology has been developed for a few species namely *Rachycentron canadum, Trachinotus blochii, Epinephelus coioides* and *Trachinotus mookalee.* However India is a hot-spot of marine finfish and shellfish biodiversity with an estimated 2,546 species of marine finfish and over 55 species of macruran decapods (Venkataraman and Mohideen, 2005). Thus in addition to the species already being studied, there may be a large number of marine species in India amenable to mariculture. However all species are not easy to culture with some providing challenges in broodstock development whereas others provide challenges during larval rearing, feeding, health management and so on. Hence even before the journey is fully undertaken, it was felt that a list of prioritized species of finfish and shellfish is needed on which focused research can be undertaken. With this objective in mind a workshop on "Species Prioritization for Mariculture/Conservation in India" was conducted at Mandapam Regional Centre of ICAR-CMFRI during 4th-6th November 2013. The specific objectives of the workshop were:

1) To prioritize finfish and shellfish species for food fish mariculture in India
2) To prioritize finfish and shellfish species for conservation mariculture in India
3) To prioritize finfish species for region-specific mariculture in India
4) To prioritize finfish and shellfish species for ornamental mariculture in India
5) To identify challenges in mariculture of prioritized species
6) To identify research gaps in species with already standardized culture protocols

The workshop was convened and chaired by Dr. A. Gopalakrishnan, Director, CMFRI. The other key participants of the workshop were Dr. G. Gopakumar, HoD, Mariculture, CMFRI along with 15 scientists of the Mariculture Division of CMFRI and one scientist from the Marine Biodiversity Division

of CMFRI. The workshop proceeded to prioritize finfish and shellfish species based on a number of criteria (presented in the next section) following active discussions among the participants. By the end of the workshop, 76 species were listed as priority species for mariculture/biodiversity conservation in India. The output of the workshop was envisaged as a book with factsheets of individual prioritized species. This publication would then serve as a guide for selecting species for mariculture in India as well as for focusing mariculture research in India.

Methodology of prioritization

A set of key factors were used for prioritizing a species for mariculture. For each factor scores from 1 to 5 were given for a species with 1 being the lowest and 5 the highest. The key factors used were:

1) Economic value of species

Domestic market value

International market value

Regional market value and preference (for region-specific species)

2) Biology of species

Size at first maturity

Feeding habit (Omnivore-Carnivore-Herbivore and amenability to utilize pelleted feed)

Growth rate

Disease resistance/hardiness

Salinity and temperature tolerance

Colour and appearance (for ornamental fish)

3) Culture-ability of species

Suitability for farming

Ease of captive broodstock development and breeding

Ease of larval rearing

Ease of nursery and grow-out rearing

Ease of handling

Compatibility with other species

Compatibility with other species in aquarium (for ornamental fish)

4) Status in wild

Availability in commercial catches

Distribution and abundance

Broodstock availability

5) Information

Data availability on biology/life-history traits/breeding/culture

6) Economics of culture

Cost-effectiveness of culture

Following the procedures mentioned, the final list of prioritized species was arrived at. Based on local availability and expertise, the species were assigned to various regional/research centres and headquarters of CMFRI for further work. Additionally some species were given higher priority for the first 5 years and other species for the following years so as to make research more efficient. Species for which seed production has already been standarised have been coloured lilac ( ), species prioritized for the first five years have been coloured green ( ) and species prioritized for the 6th year onwards have been coloured blue ( ) in the following chapters. Scientific names of the species and their classification are based on World Register of Marine Species (www.marinespecies.org) as on 18th October 2017.

Recommendations of the workshop

Prioritized species for mariculture (food fishes)

The main objective of the workshop was to prioritize marine finfish and shellfish species for mariculture in India and to identify constraints/challenges for each species. The workshop identified 23 finfish species, 7 molluscan species, 4 shellfish species and 2 species of sea urchins for mariculture in India. Among the prioritized species, for *Epinephelus coioides, Trachinotus blochii, Trachinotus mookalee* and *Rachycentron canadum* the seed production technology has already been standardized; however, year round natural spawning, development of artificial feed and grow-out are issues which needs to be addressed and refined in the first five years. The other prioritized finfishes were *Caranx ignobilis, Gnathanodon speciosus, Lutjanus argentimaculatus* and *Lutjanus johnii* for the first five years and for later years *Acanthopagrus berda, Caranx sexfasciatus, Coryphaena hippurus, Cromileptes altivelis, Eleutheronema tetradactylum, Epinephelus malabaricus, Katsuwonus pelamis, Lethrinus lentjan, Lethrinus nebulosus, Pampus argenteus, Pampus chinensis, Parastromateus niger, Psettodes erumei, Siganus canaliculatus* and *Thunnus albacares*. The prioritized molluscan species were *Crassostrea madrasensis* and *Perna viridis* for the first five years and *Marcia opima, Meretrix meretrix, Paphia malabarica, Perna indica* and *Tegillarca granosa* for later years. The prioritized shellfish species were *Portunus pelagicus* and *Thenus unimaculatus* for the first five years and *Panulirus*

homarus homarus and *Panulirus ornatus* for later years. The prioritized sea urchins were *Stomopneustes variolaris* and *Echinometra mathaei.* The constraints identified in most species were lack of information on life history traits, captive breeding, larviculture, feed and farming systems. It was recommended that for most species, studies on biology and life history were to be initiated. For species where broodstock development had been initiated, it was to be continued and for species where breeding had occurred, larval rearing was to be standardized and for species where larval rearing had been perfected, nursery and grow out practices/protocol were to be standardized.

Prioritized species for region-specific mariculture

Four species were prioritized for region-specific mariculture namely *Mugil cephalus* for Kerala, *Sillago sihama* for the south Canara coast, *Protonibea diacanthus* and *Otolithoides biauritus* for the north-west coast of India. The constraints were lack of information and research on captive breeding, seed production, larval rearing, feed management and farming systems in addition to lack of information on biology for the latter two species. Hence it was recommended that relevant studies should be undertaken for each species at the identified regions.

Prioritized species for conservation mariculture

Five species were identified for conservation through mariculture and subsequent sea ranching. The species identified were *Hippocampus kuda* and *Holothuria spinifera,* for the first five years. Three additional species were identified for work during 6th to 10th year namely *Epinephelus lanceolatus, Hippocampus trimaculatus* and *Holothuria scabra*. The constraints identified were lack of information on life history traits including reproductive biology, seed production and genetic stock structure. It was recommended that for the identified finfish species biological studies would be conducted with emphasis on genetic stock structure studies. For the identified shellfish and invertebrates, large scale sea ranching would be conducted pending clearance from Ministry of Environment & Forests, Govt. of India.

Prioritized species for ornamental mariculture

Thirty one species of finfish, shellfish and other invertebrates were identified for ornamental mariculture in India namely *Centropyge flavipectoralis, Chromis viridis, Chrysiptera cyanea, Dascyllus aruanus, Dascyllus trimaculatus, Labroides dimidiatus, Nemateleotris decora, Neoglyphidodon oxyodon, Platax teira, Pomacanthus semicirculatus, Pomacentrus pavo, Pseudanthias squamipinnis, Pseudochromis dilectus, Lysmata amboinensis, Ancylocaris brevicarpalis, Petrarctus rugosus, Entacmaea quadricolor, Heteractis magnifica, Stichodactyla gigantea, Cladiella australis, Xenia elongata, Cypraea tigris, Lambis lambis, Pinctada fucata, Pinctada margaritifera, Placuna placenta, Spondylus layardi, Tectus niloticus, Tridacna maxima, Turbo marmoratus* and *Volachlamys tranquebaria.* The constraints identified were larval survival, scaling up of seed production, breeding and seed production, lack of information on life history traits and artificial propagation.

Summary of factsheets

Following the workshop and its recommendations, base papers of the prioritized species were prepared. Several authors compiled information on biology, culture practices, diseases and trade for the prioritized species.

Food fishes

All the authors in addition to compiling the available information on each species have highlighted the need for more information on biology of the prioritized species from Indian waters. Groupers hold sway in the live reef fish trade and have been intensely cultured in south-east Asian countries. Being a hardy species and good domestic as well as international market, these species are having good prospect as an alternate species for Indian fish farmer. However, the availability of seeds is the major concern for its culture, because of difficulty in larval rearing due to small mouth gape as most of them are altricial type of larvae. Cobia and pompano (Indian and snubnose) being euryhaline are amenable for culture in coastal ponds and cages. They possess fast growth rate and excellent meat quality and hence are excellent species for mariculture.

Two species of perches of the genus *Lutjanus* are highly prized in the Indian market, but for which hatchery technology needs to be developed. The larvae of *Lutjanus* spp. are also of the altricial type, which need to be reared on smaller size copepod nauplii. *Acanthopagrus berda* is highly prized in the domestic market; however, no information is available on its biology and culture.

Indian salmon, *Eleutheronema tetradactylum* is a popular fish nationally but very limited information is available on its biology and culture. Three species of pomfrets of the genus *Pampus* and *Parastromateus* have been selected based on their popularity among Indians and great demand from Gulf countries. Though their larvae have survived in captivity, much more work has to be carried out on development of their broodstock and hatchery technology with grow-out practices.

Two carangids, *Caranx ignobilis* and *C. sexfasciatus*, present in Indian waters, are fast growing species. *C. ignobilis* has already been bred in captivity however its larval rearing, grow-out and farming systems need to be developed. Golden trevally, *Gnathanodon speciosus* is a popular food and ornamental fish, for which broodstock development, breeding and larval rearing protocol need to be developed in India. Rabbit fish, *Siganus canaliculatus* is one of the most economically important herbivorous fish having good potential for cage culture in India. However, their seed production technology needs to be worked out. *Psettodes erumei* is a highly valued table-fish whose broodstock development has been achieved in India; however, breeding and larval rearing of this species needs to be worked out.

Thunnus albacares, *Katsuwonus pelamis* and *Coryphaena hippurus* are known for their premium flesh quality in international market and can be good mariculture species for off shore cage culture. Steady progress has been reported about their breeding, hatchery and grow-out technologies from

other countries; however in India, research attempt has to be initiated. Emphasis has to given for studying the biology of *Lethrinus nebulosus* and *Lethrinus lentjan,* as a prerequisite for developing broodstock, hatchery technology and grow-out system. *Crassostrea madrasensis, Perna viridis, Perna indica* and *Tegillarca granosa* have high local demand in domestic markets in selected pockets of the country and their broodstock development and seed production has been achieved on an experimental basis. However, cost-effective mass scale seed production needs to be worked out for scaling up the culture of these molluscan species. *Marcia opima, Meretrix meretrix* and *Paphia malabarica* enjoy a good demand for direct human consumption as well as in the shrimp feed industry. These species are also important inputs in the carbide industry. To meet these multifarious needs, mass scale seed production technology of these species needs to be developed.

Other than shrimps, lobsters *(Thenus unimaculatus, Panulirus homarus homarus* and *P. ornatus)* and marine crabs *(Portunus pelagicus)* are the other shellfish with high potential for culture with very high demand in domestic as well as international markets. However these species are mainly cultured with wild collected seed or adults for fattening due to lack of hatchery produced seeds. Thus the currently available nascent seed production technology must be standardized to meet the demand. Sea urchins like *Stomopneustes variolaris* and *Echinometra mathaei* have considerable demand for local fisherman communities. The life history, breeding and seed production need to be studied for these species.

Region - specific species

Some species like *Sillago sihama, Mugil cephalus, Protonibea diacanthus* and *Otolithoides biauritus* have localized market demand in some parts of the country. Although it is in a small scale, the demand is rising due to depleting wild catch. To supplement their capture fishery, it is very essential to develop their breeding and seed production technology to support their culture practices. Although *Mugil cephalus* has a patchy demand within and outside the country, it is a well-established farmed fish consumed in fresh and preserved condition. As its farming mainly relies on wild collected seeds, it is essential to develop its breeding and larval rearing technology to further develop its farming as well as to conserve the resource in the wild. The fishery of *Sillago sihama* is drastically decreasing but it has a high demand along the west coast of India. The air bladders of *Protonibea diacanthus* and *Otolithoides biauritus* make it a very lucrative candidate for mariculture. Thus research needs to be initiated in the direction of broodstock development and hatchery technology for *Sillago sihama, Protonibea diacanthus* and *Otolithoides biauritus.*

Conservation

Among the species identified for conservation, the most important are *Hippocampus kuda, Hippocampus trimaculatus* and *Holothuria scabra* for which seed production technologies are very well developed. These technologies must be used to produce quality seed on a large scale for ranching to increase their wild populations. Other species recommended for conservation, like

Holothuria spinifera and *Epinephelus lanceolatus* need to be studied for their biology to develop their breeding and seed production for ranching purposes.

Ornamental species (Teleosts/Invertebrates)

Many marine ornamental species of commercial importance have not been produced successfully under controlled conditions due to their delicate life cycle and environmental requirements. Although breeding and seed production of many ornamental fish species has been achieved, seed production is limited to small scale hatcheries due to many constraints such as difficulty in broodstock development and poor larval survival. These issues need to be addressed urgently to boost up their culture industry as well as for promotion of their export. *Pinctada fucata* and *Pinctada margaritifera* are valuable species for the pearl industry. A cost-effective hatchery technology needs to be developed for these two species. The other molluscan species included in this book enjoy a good demand in the ornamental shell craft industry for making ornaments like pearl buttons, pendants, ear rings, necklaces, bangles and decorative items. However, information is lacking on their life history and breeding which in turn is an obstacle for their culture.

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SPECIES ALREADY STANDARDISED

Food Fishes

Finfishes

1. *Epinephelus coioides*
2. *Trachinotus blochii*
3. *Trachinotus mookalee*
4. *Rachycentron canadum*

SPECIES PRIORITIZED FOR FIRST FIVE YEARS

Food Fishes

Finfishes

1. *Caranx ignobilis*
2. *Gnathanodon speciosus*
3. *Lutjanus argentimaculatus*
4. *Lutjanus johnii*

Molluscs

1. *Crassostrea madrasensis*
2. *Perna viridis*

Crustaceans/Other Invertebrates

1. *Portunus (Portunus) pelagicus*
2. *Thenus unimaculatus*

Region specific species for mariculture

1. *Mugil cephalus*

Conservation/Sea-ranching

1. *Hippocampus kuda*
2. *Holothuria (Theelothuria) spinifera*

Ornamental species (Teleosts/Invertebrates)

1. *Centropyge flavipectoralis*
2. *Chromis viridis*
3. *Chrysiptera cyanea*
4. *Dascyllus aruanus*
5. *Dascyllus trimaculatus*
6. *Nemateleotris decora*
7. *Neoglyphidodon oxyodon*
8. *Pomacentrus pavo*
9. *Pseudochromis dilectus*
10. *Entacmaea quadricolor*
11. *Pinctada fucata*
12. *Pinctada margaritifera*

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